Solar and Heliospheric Models at the Community Coordinated Modeling Center

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What is CCMC?

Multi-agency activity to

- Aid in the development of space weather prediction models
- Bridge the transition from research to operations
- Provide access to state-of-the-art research models to the scientific community

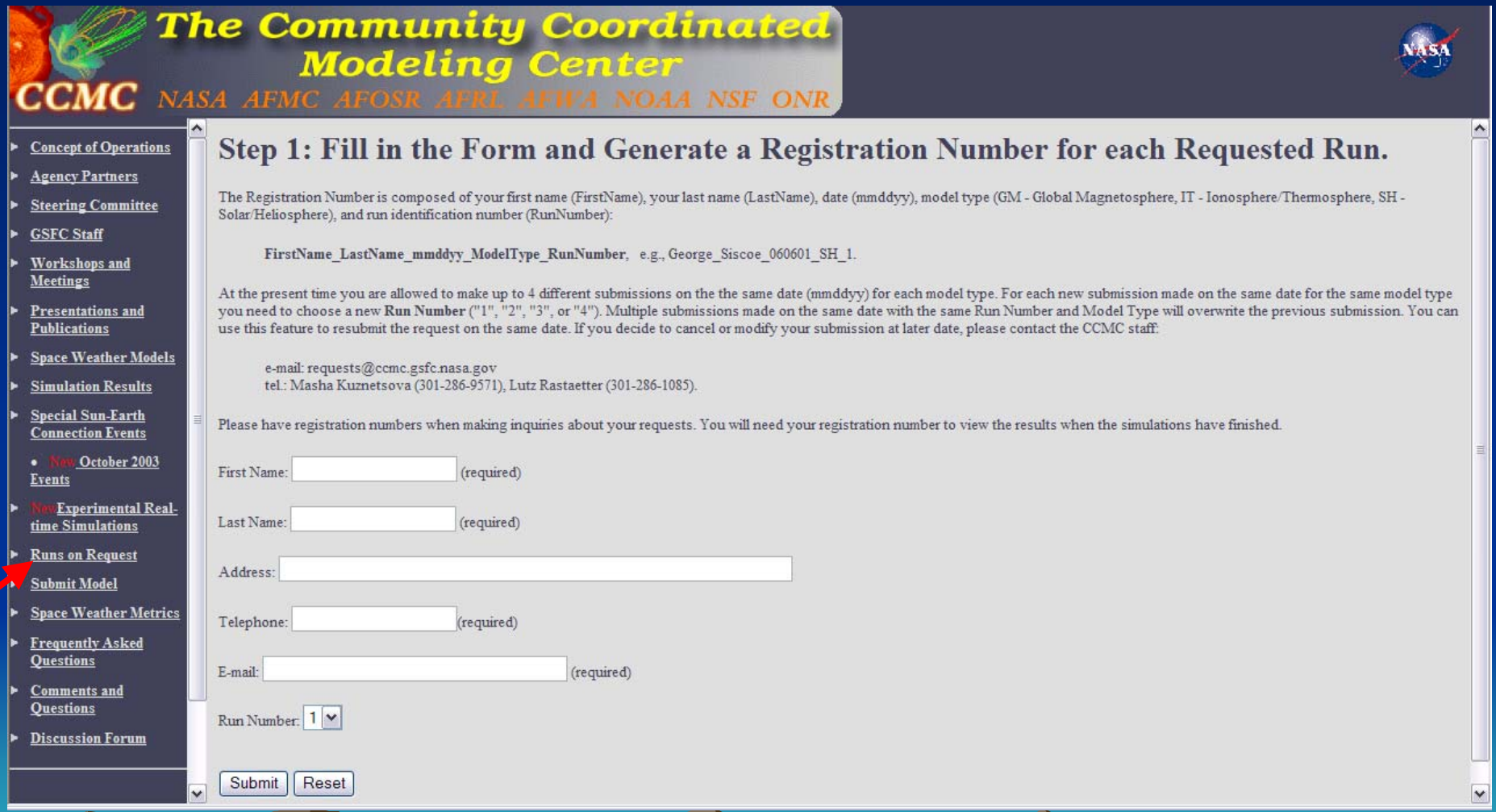
CCMC Activities

- Model Validation
- Metric Studies
- Advanced Visualization Tools
- Execute Runs on Request
- Transfer Models to the Operational Community
- Perform Data Format Studies

Solar and Heliosphere Models

- MAS Solar Corona (*J. Linker, Z. Mikic et al.,* SAIC)
- Source Surface Model (*J. Luhmann et al.,* UCB)
- Heliospheric Tomography (*B. Jackson et al.,* CASS/UCSD)
- Exospheric Solar Wind (*Lamy, Pierrat,* IASB, Belgium)
- Heliospheric MHD Model (*D. Odstrcil*)

Runs on Request



Runs on Request

Step 3: Set The Simulation Time Interval

Choose Carrington rotation or date of interest

Select:

(•) **Carrington rotation number** between 1625 and 2007: 2007

or

( ) **Date** (MM/DD/YYYY) between 02/18/1975 and 08/29/2003 08 / 29 / 2003

Selection of Carrington rotation numbers and dates is subject to change.

Specify the duration of the run

40 hours

Maximum duration of the run is 80 hours of real time.
Minimum duration of the run is 5 hours of real time.

Step 4: Set The Simulation Grid

Select **grid resolution (NRxNTxNP)** from predefined list:

low-resolution (61x51x32)

Continue

Step 5: Set The Boundary Conditions

Confirm selection of Carrington Rotation based on available data

Rotation: 2007 Start: 08/29/2003 End: 09/26/2003

Select coronal base temperature and density

Coronal base temperature: 1.6 x 10^6 [K]

Coronal base density: 2 x 10^8 [particles cm^{-3}]
(density range: (1.0 - 4.0) x 10^8 [particles cm^{-3}])

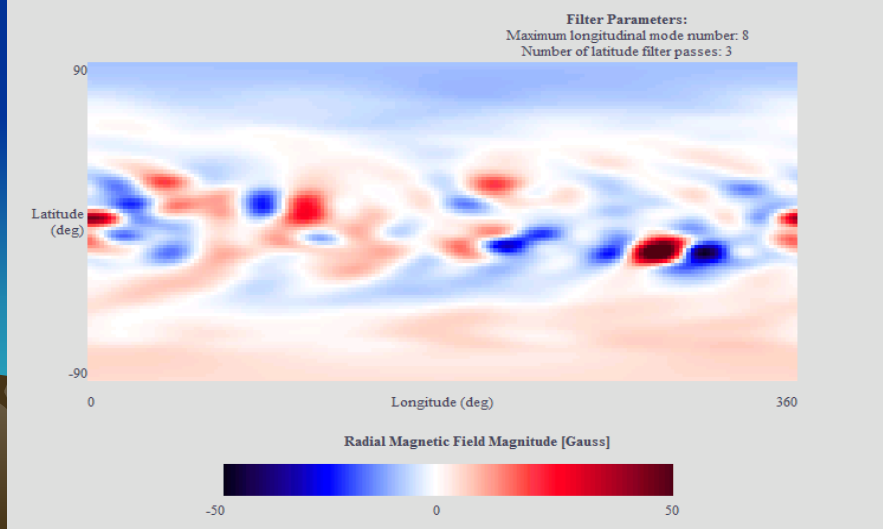
Select filter parameters for magnetogram data

Selected simulation grid: **medium resolution (85x81x64)**
Recommended maximum longitudinal mode number: 8
Recommended number of latitude filter passes: 3
Recommendations and ranges for filter parameterns are based on grid resolution.

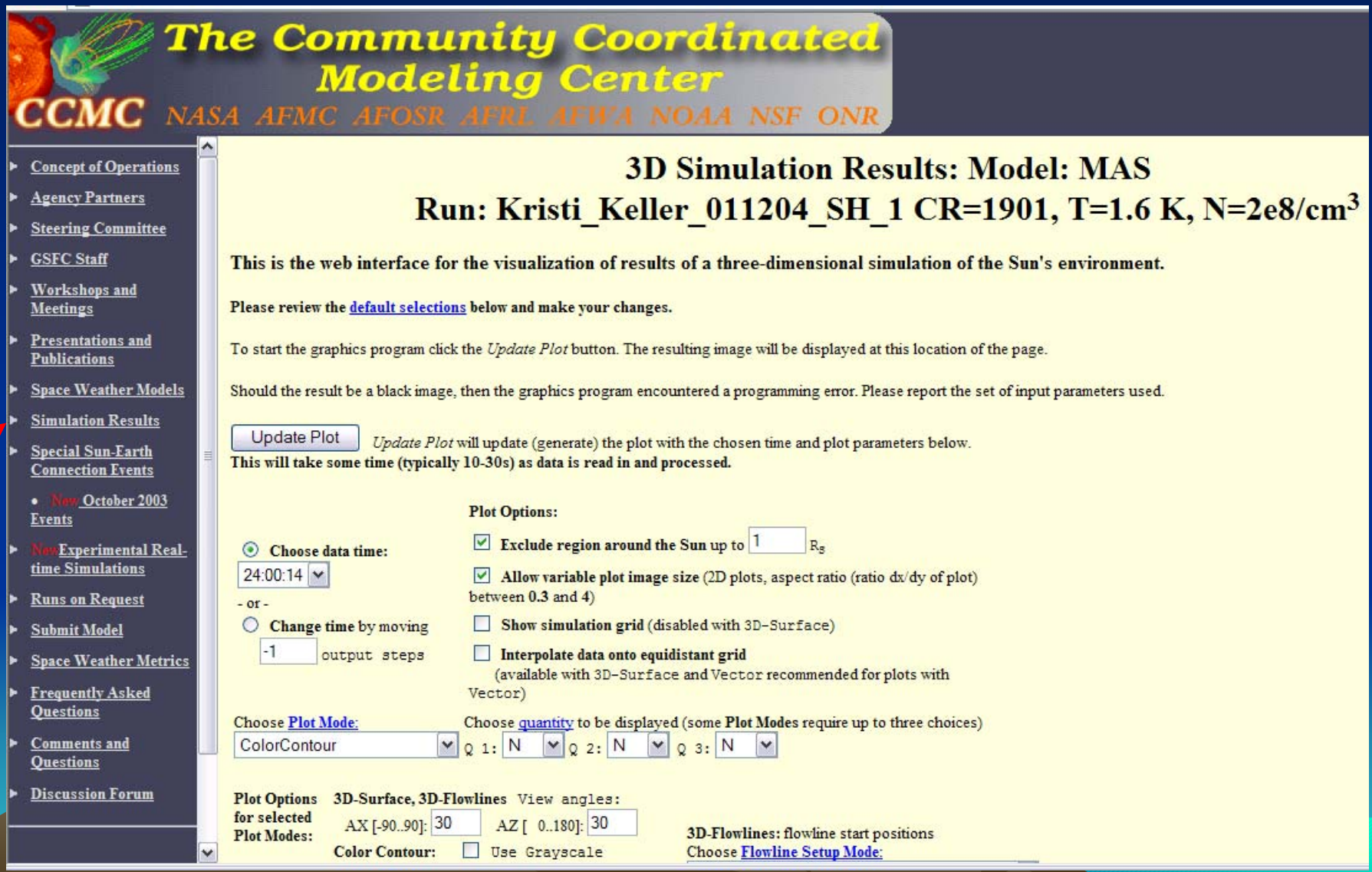
Maximum longitudinal mode number (Range: 1 - 9) 8

Number of latitude filter passes (at least 2): 3

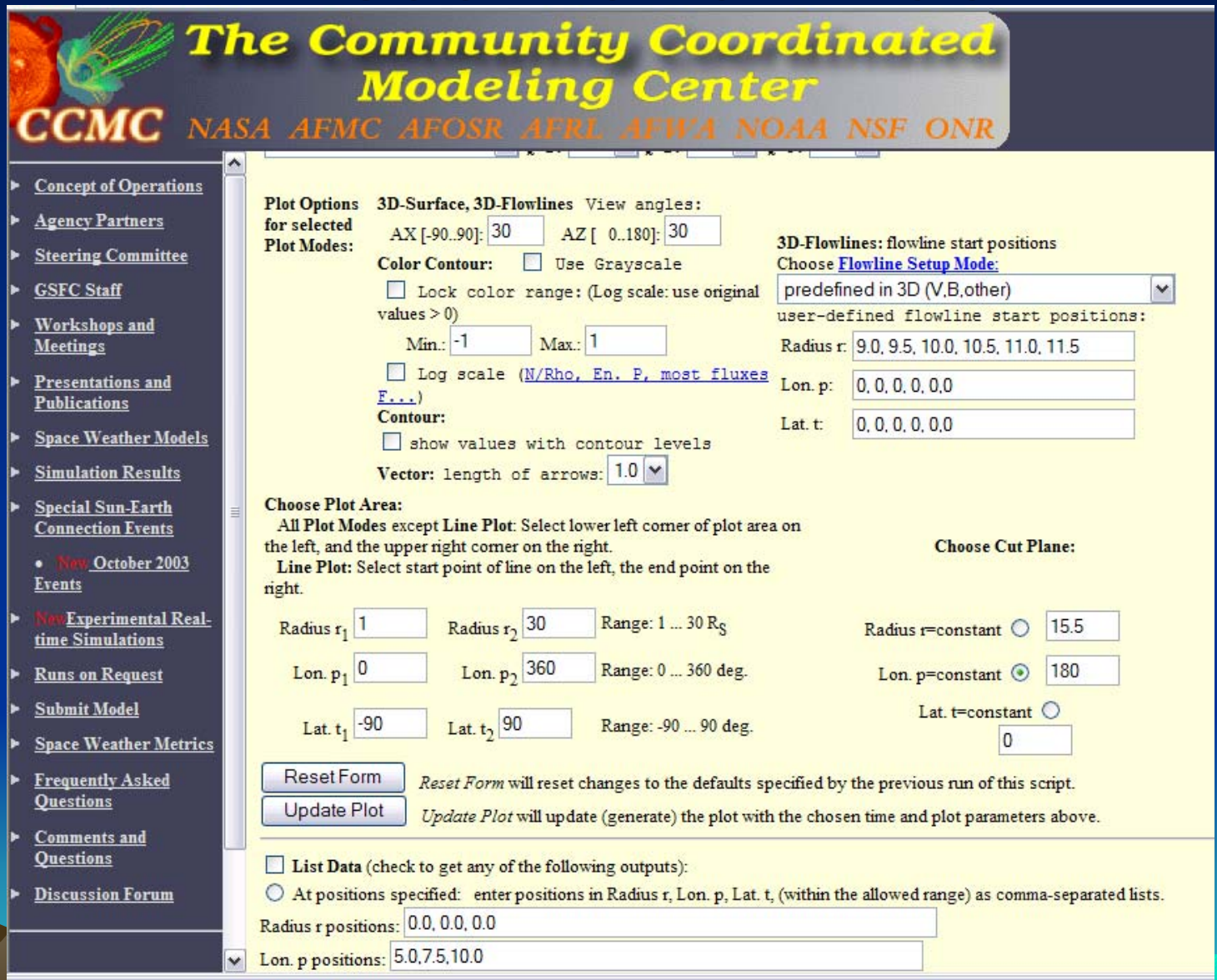
Filtered Kitt Peak Magnetogram



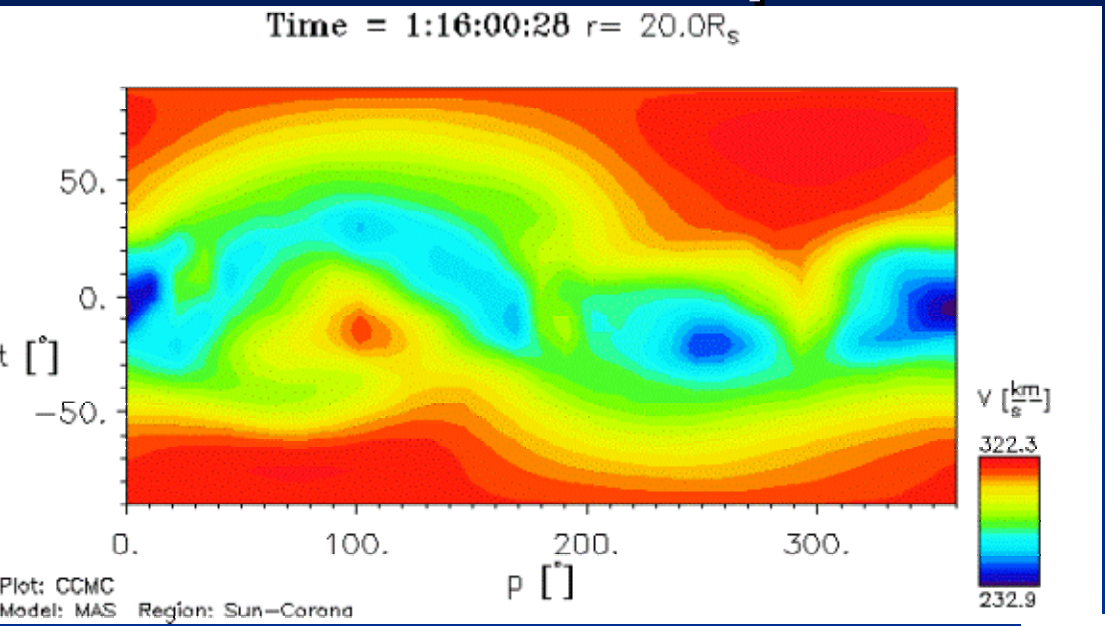
Visualization Tool



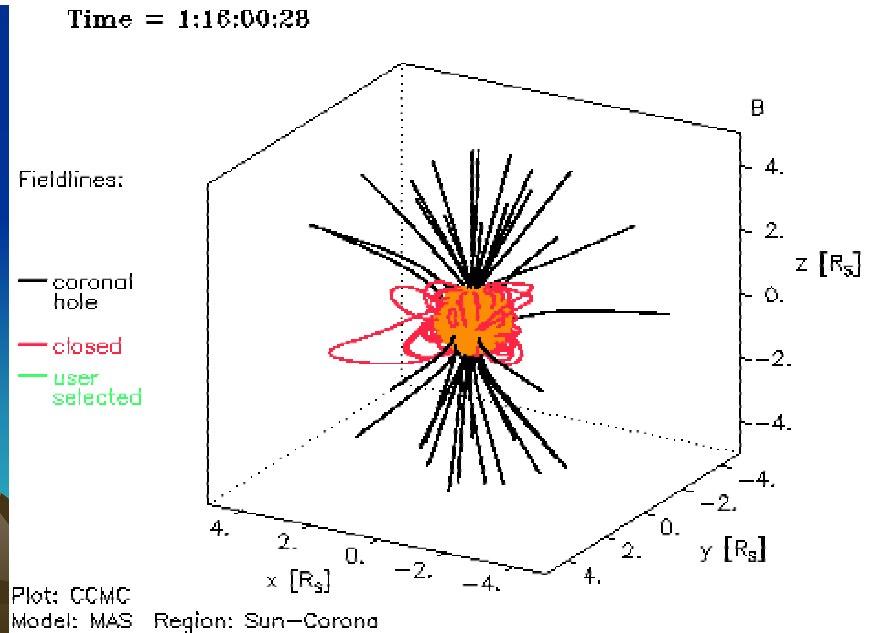
Visualization Tool



Examples of Output

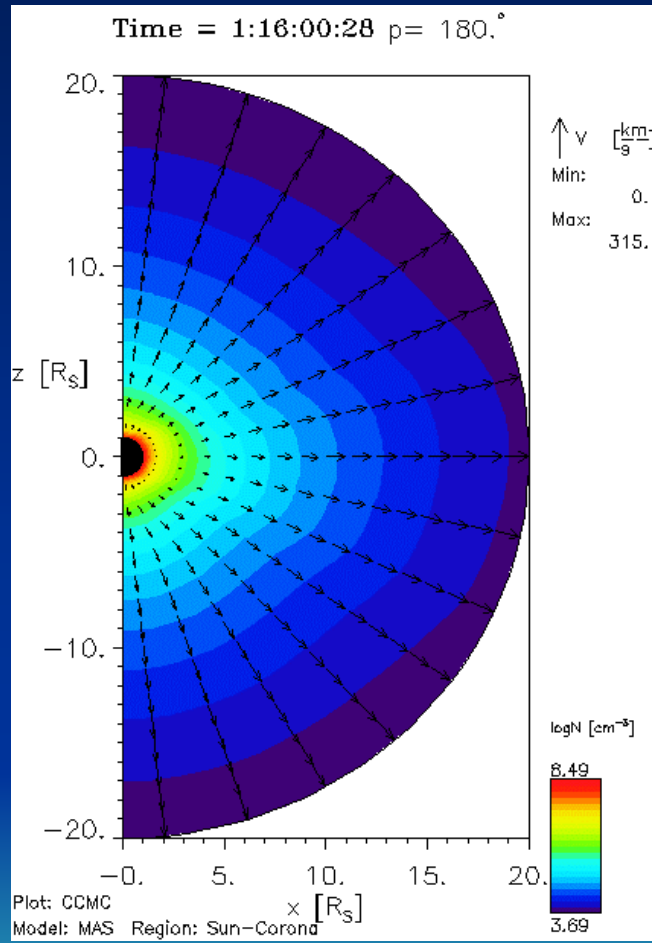


- Color Contour Plots
- Vector Plots
- Fieldlines
- Line Plots



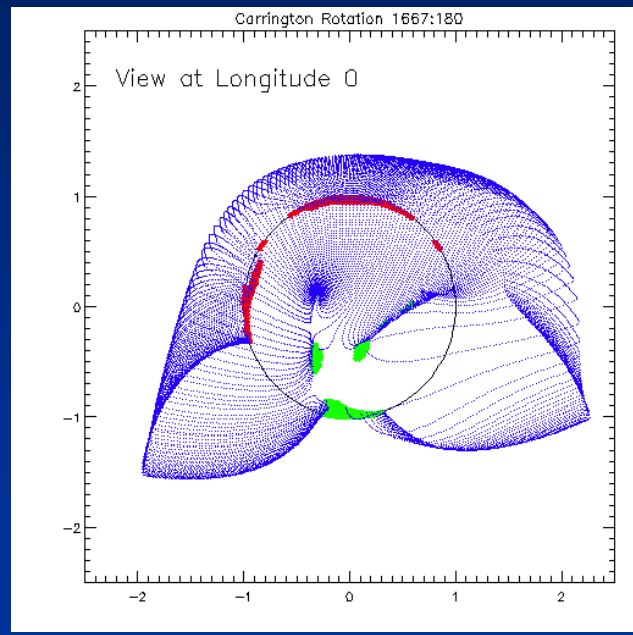
Solar MAS

- MHD equations
- Photospheric magnetic field data is used for the boundary condition on Br.
- Solved to steady state
- Input at Photosphere
  - Magnetic field (CCMC web site user enters date)
  - Density
  - Temperature
- Output
  - Magnetic field
  - Velocity
  - Density
  - Temperature



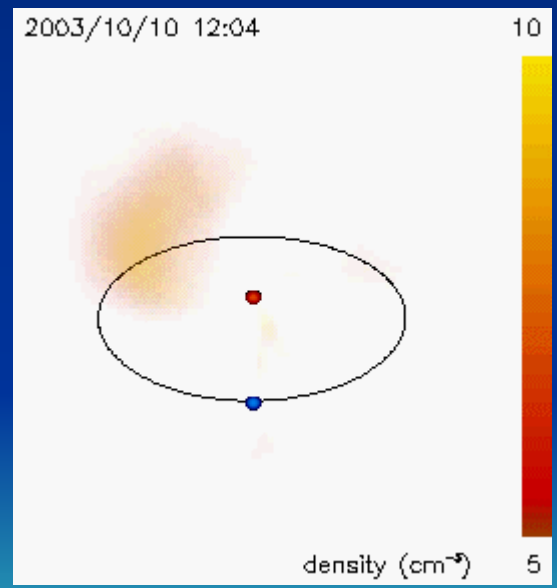
Potential Source Surface Model

- The model calculates the magnetic field of the corona from the radius of the sun to the source surface radius assuming that there are no currents in this region.
- The code uses spherical harmonic coefficients calculated by Wilcox Solar Observatory using observed photospheric fields (magnetograms) as input.
- User input:
  - Date
  - Source Surface Radius (1.6 – 3.25 R_s)
  - Number of spherical harmonic coefficients
- Output – Magnetic Field Mappings



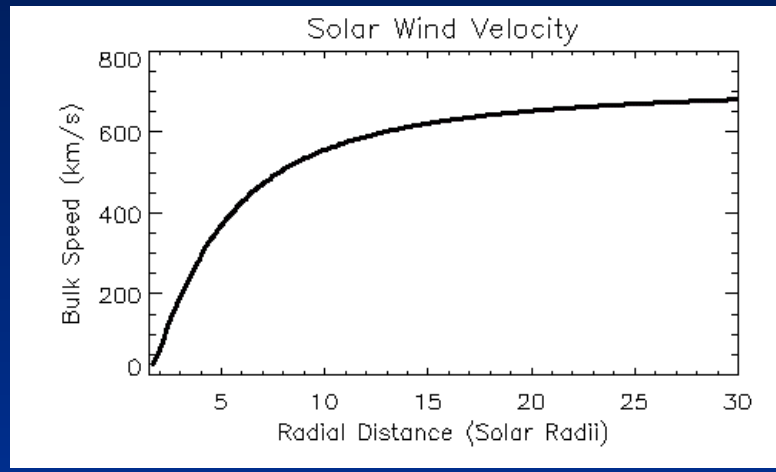
Heliospheric Tomography

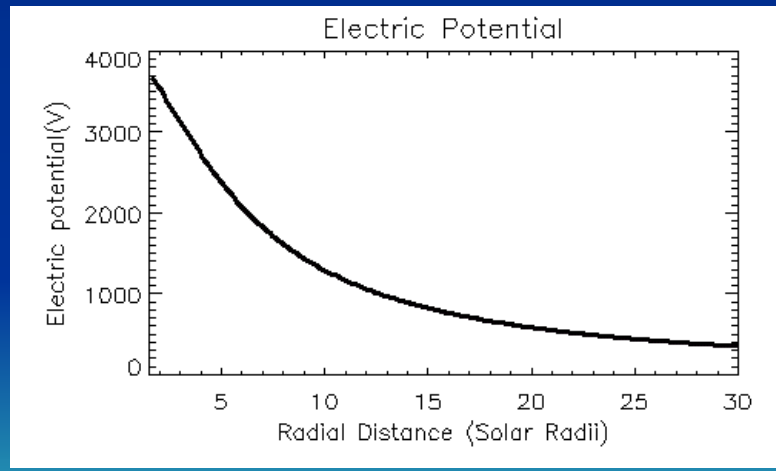
- Kinematic model using conservation rules
- Density and velocity specified on source surface
- Using kinematic model, IPS velocity and g-level data are calculated by the model and compared with observations. Using an iterative least-squares algorithm, the source surface is updated to obtain the best model for the solar wind.
- Input for CCMC web site user: Date
- Output
  - Radial Velocity
  - Density



Exospheric Solar Wind Model

- One-dimensional kinetic model developed for coronal holes
- Uses quasi-neutrality to obtain a radial distribution of the electrostatic potential.
- Calculates the moments of the electron and proton velocity distribution function (VDF) using the electrostatic potential
- Input
  - Radial distance of exobase
  - Temperature of the electrons and protons at the exobase
  - Kappa index for electrons VDF
  - Radial distance of end point
- Output
  - Density
  - Flux of particles
  - Bulk velocity of solar wind
  - Temperature of electrons and protons
  - Electric potential





Odstrcil Heliosphere Model

- MHD equations solved from 20 to 220 R_s
- Input at inner boundary
  - MHD parameters
- Output
  - Magnetic field
  - Velocity
  - Density
  - Temperature

Model Selection at the CCMC

Models are selected by the Steering Committee using the following guidelines:

- Relevance to the research and operational goals of the National Space Weather Program
- Compatibility with existing resources at CCMC
- Reliability
- Documentation

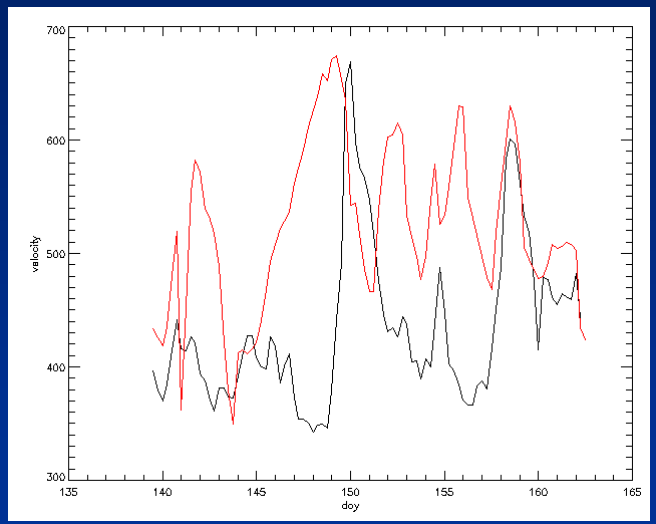
Heliospheric Tomography

Velocity

Density

700

300



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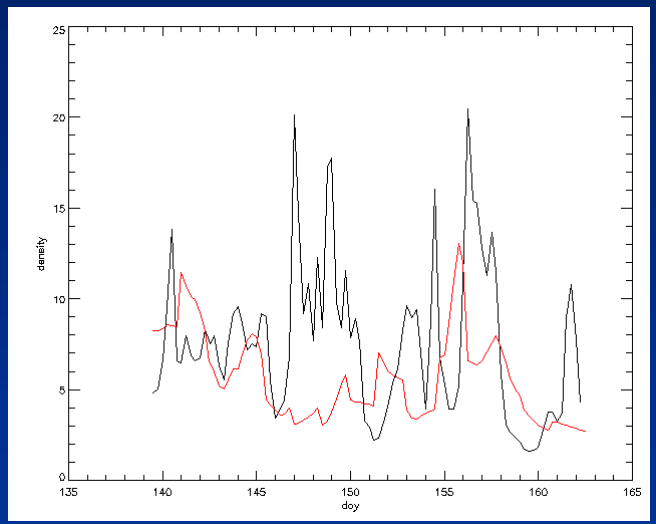
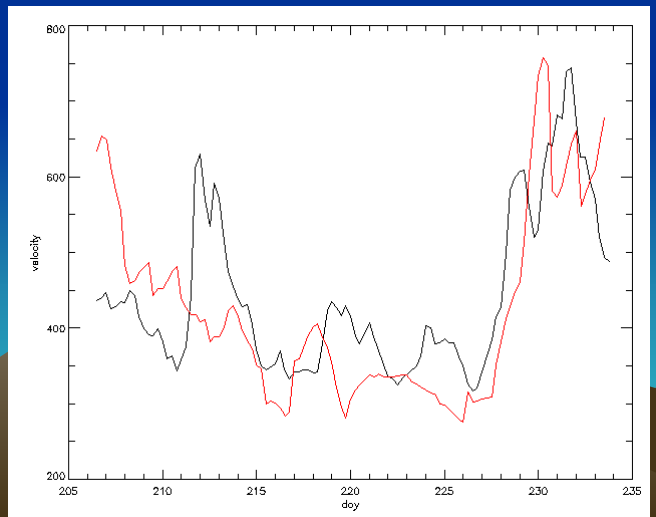


Interval 1

800

300



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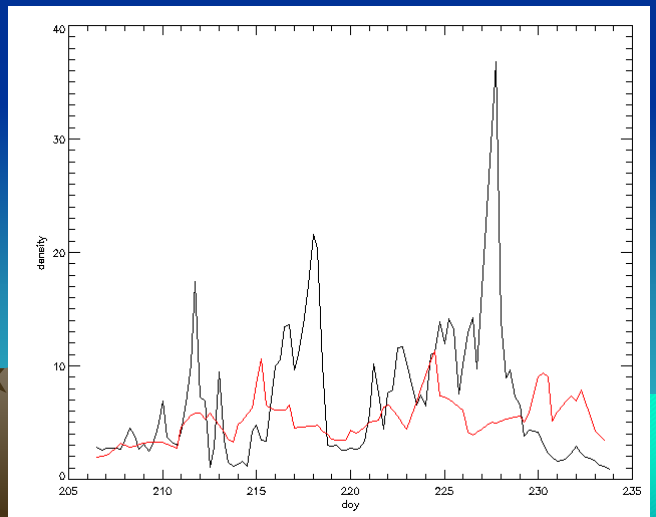

Interval 2